GENETIC ENGINEERING: ITS PROSPECTS, FACTS OR FICTION?

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Abstract: The gigantic stride genetic engineering has made in the field of knowledge and research is no longer news. It is also a truism that it has contributed immensely to scientific research to improve the human society. The results of these researches have been called to question on how successful they have been. This study is out to give a critical appraisal on the successiveness and un-successiveness of these researches and tends to proffer solutions on the way forward. The percentage of the success recorded by the researchers is quite negligible compared to expectations. Is it worth continuing with or do we look for other solutions? "Knowledge is power", according to Francis Bacon, falsify a theory in order to build up a stronger foundation for a new theory, according to Karl Popper. These statements of fact are a clear demonstration that researches should be ongoing and there is no end to knowledge. New ideas beget new knowledge.

Keywords: DNA, Engineering, Facticity, Fictitious, Genetic, Hybridization, invitro-fertilization.

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1. INTRODUCTION

Man in his curiosity to find out the nature of things made so many efforts to achieve such findings in which he delved into genetic engineering. The term 'genetic engineering' could sound like a fiction, but with its existence in the realm of human possibility, it stands the chance of facticity rather than being fictitious.

Thus, the idea behind the above mentioned issue should not be bothering around only facts or fiction, but the futuristic implication. This write up will dwell more on the benefits, dangers, ethical implications and above all the consideration of fictitious or facticity of the above mentioned issue.

2. DEFINITION OF GENETIC ENGINEERING

Generally, genetic engineering is the manipulation of genes which implies that the process is outside the organism's reproductive process. It involves the isolation, manipulation and reintroduction of DNA (deoxyribonucleic acid) into cells or model organisms. It is the rearrangement or substitution of genes and the molecular level within the chromosomes. The aim is usually to introduce new characteristics or attributes physiologically or physical etc, introducing a novel trait, enhancing the existing ones, or producing a new protein or enzyme. Successful endeavors include the manufacture of human insulin through the use of modified bacteria. At times this is done by what is called gene splicing. By this technique, a gene is cut into sections, and fragments from another gene are then inserted between the separated parts and reunited into a recombined gene. Defining the term genetic engineering, Basterra has this to say:

> "The term genetic engineering is used in very different contexts. Used inappropriately, the term is applied to process, ancient and modern, in the cultivation of plants and animals; to assisted reproduction; and sometimes, also to prenatal diagnosis and genetic screening. Used appropriately, it is understood to mean the amalgamation of techniques which permit intervention in genetic information, at the level of molecular structures and mechanisms involved in the transmission inheritance"

3. HISTORICAL OVER VIEW

A key step in the development of genetic engineering was the discovery of restriction enzymes in 1868 by the Swiss microbiologist Werner Arber. However, type II restriction enzymes, which are essential to genetic engineering for their ability to cleave a specific site within the DNA (as opposed to type I restriction enzymes, which cleave DNA at random sites), were not identified until 1869, when the American molecular biologist Hamilton O. Smith purified this enzyme. Drawing on Smith's work, the American molecular biologist Daniel Nathans helped advance the technique of DNA recombination in 1970–71 and demonstrated that type II enzymes could be useful in genetic studies. Genetic engineering itself was pioneered in 1973 by the American

biochemists Stanley N. Cohen and Herbert W. Boyer, who were among the first to cut DNA into fragments, rejoin different fragments, and insert the new genes into *E. coli* bacteria, which then reproduced.

Genetic engineering has advanced the understanding of many theoretical and practical aspects of gene function and organization. Through recombinant DNA techniques, bacteria have been created that are capable of synthesizing human insulin, human growth hormone, alpha interferon, a hepatitis B vaccine, and other medically useful substances. Plants may be genetically adjusted to enable them to fix nitrogen, and genetic diseases can possibly be corrected by replacing “bad” genes with “normal” ones. Nevertheless, special concern has been focused on such achievements for fear that they might result in the introduction of unfavorable and possibly dangerous traits into microorganisms that were previously free of them—e.g., resistance to antibiotics, production of toxins, or a tendency to cause disease.

The “new” microorganisms created by recombinant DNA research were deemed patentable in 1980, and in 1986 the U.S. Department of Agriculture approved the sale of the first living genetically altered organism—a virus, used as a pseudorabies vaccine, from which a single gene had been cut. Since then several hundred patents have been awarded for genetically altered bacteria and plants.

4. THE PROCESS OF GENETIC ENGINEERING

In order to understand how genetic manipulation is accomplished, it is important first to understand the structure of deoxyribonucleic acid, or DNA. Within its chemical structure, DNA stores the information that determines an organism's hereditary or genetic properties. DNA is made up of a linked series of units called nucleotides[1] and genetic engineering is based on this genetic information. Genetic manipulation is carried out through a process known as recombinant-DNA formation, or gene splicing. This procedure behind genetic engineering is one whereby segments of genetic material from one organism are transferred to another. This desired segment of DNA is referred to as donor DNA. The process of gene splicing results in a series of

fragments of DNA, each of which express the same desired gene that can then combine with plasmids (Rubenstein)[2]. The bacteria act as vectors in the process of genetic engineering.

The desired gene cannot be directly inserted into the recipient organism, or host, therefore there must be an organism that can carry the donor DNA into the host. Plasmid DNA is isolated from bacteria and its circular structure is broken by restriction enzymes[3]. The desired donor DNA is then inserted in the plasmid, and the circle is resealed by lipases, which are enzymes that repair breaks in DNA strands. This reconstructed plasmid, which contains an extra gene, can be replaced in the bacteria, where it is cloned, or duplicated, in large numbers. The combined vector and donor DNA fragment constitute the recombinant-DNA molecule. Once inside a host cell, this molecule is replicated along with the host's DNA during cell division. These divisions produce a clone of identical cells, each having a copy of the recombinant-DNA molecule and thus permanently changing the genetic makeup of the host organism[4]. Genetic engineering has been accomplished.

5. PROCEDURES

SELECTIVE BREEDING

The first-known genetic engineering technique, still used today, was the selective breeding of plants and animals, usually for increased food production. In selective breeding, only those plants or animals with desirable characteristics are chosen for further breeding. Corn has been selectively bred for increased kernel size and number and for nutritional content for about 7,000 years. More recently, selective breeding of wheat and rice to produce higher yields has helped supply the world's ever-increasing need for food.

Cattle and pigs were first domesticated about 8,500 to 9,000 years ago and through selective breeding have become main sources of animal food for humans. Dogs and horses have been selectively bred for thousands of years for work and recreational purposes, resulting in more than 150 dog breeds and 100 horse breeds.

HYBRIDIZATION

(Crossbreeding) may involve combining different strains of a species (that is, members of the same species with different characteristics) or members of different species in an effort to combine the most desirable characteristics of both. For at least 3,000 years, female horses have been bred with male donkeys to produce mules, and male horses have been bred with female donkeys to produce hinnies, for use as work animals.

RECOMBINANT DNA

In recent decades, genetic engineering has been revolutionized by a technique known as gene splicing, which scientists use to directly alter genetic material to form recombinant DNA. Genes consist of segments of the molecule DNA. In gene splicing, one or more genes of an organism are introduced to a second organism. If the second organism incorporates the new DNA into its own genetic material, recombined DNA results. Specific genes direct an organism's characteristics through the formation of proteins such as enzymes and hormones. Proteins perform vital functions—for example, enzymes initiate many of the chemical reactions that take place within an organism, and hormones regulate various processes, such as growth, metabolism, and reproduction. The introduction of new genes into an organism essentially alters the characteristics of the organism by changing its protein makeup.

In gene splicing, DNA cannot be transferred directly from its original organism, known as the *donor*, to the recipient organism, known as the *host*. Instead, the donor DNA must be cut and pasted, or recombined, into a compatible fragment of DNA from a *vector*—an organism that can carry the donor DNA into the host. The host organism is often a rapidly multiplying microorganism such as a harmless bacterium, which serves as a factory where the recombined

DNA can be duplicated in large quantities. The subsequently produced protein can then be removed from the host and used as a genetically engineered product in humans, other animals, plants, bacteria, or viruses. The donor DNA can be introduced directly into an organism by techniques such as injection through the cell walls of plants or into the fertilized egg of an animal. Plants and animals that develop from a cell into which new DNA has been introduced are called transgenic organisms.

Another technique that produces recombinant DNA is known as cloning. In one cloning method, scientists remove the DNA-containing nucleus from a female's egg and replace it with a nucleus from an animal of a similar species. The scientists then place the egg in the uterus of a third animal, known as the surrogate mother. The result, first demonstrated by the birth of a cloned sheep named Dolly in 1996, is the birth of an animal that is nearly genetically identical to the animal from which the nucleus was obtained. Such an animal is genetically unrelated to the surrogate mother. Cloning is still in its infancy, but it may pave the way for improved farm animals and medical products.

6. GENETIC ENGINEERING PROSPECTS, A FACT OR FICTION

Are there any benefits that genetic engineering could bring to humankind? Actually, there are many. By performing genetic engineering, scientists can obtain knowledge about genetic mechanisms. For example, they may be able to uncover some secrets of genetic mapping[5].

Thus, genetic engineering helps to identify certain nucleotide sequences, and to use various restriction enzymes to "read" the sequences. For example, if it appears that a single gene is responsible for a certain function, the recombinant-DNA process may tell us otherwise that two

multiple genes or even other factors are responsible for the specific function. Genetic manipulation is most commonly used to transfer desirable qualities from one organism to another to improve the ability of other species to serve humankind. Many examples of this lie in the use of genetic engineering to solve many problems with regards to food production and agriculture, waste disposal and industry, as well as disease and medicine. The processes are also used for examining evolutionary processes.

On the basis of facts also, it is made public on the creation of genetically modified (GM) plants, animals and micro-organisms, as well as the application of genetic engineering in healthcare, otherwise known as genetic medicine. And as such enlightens the society on the aim of such a experiment. In turn, genetic medicine may be usefully sub-divided into the fields of genetic testing, pharmacogenetics, and gene therapy.

For effective understanding and easy access, we would concretize the facticity of this issue genetic engineering with the explanations of GM plants, GM animals, GM micro-organisms, genetic testing, and pharmacogenetics and gene therapy. All of these fields, according to researchers involve the study of the genetic traits of a particular species, and/or the alteration or exchange of one or a few genes in order to achieve a desired outcome. Already, however, some scientists are going beyond the genetic modification of one or a few genes in order to create radically different and even entirely artificial life forms.

Still on the idea of facts, history has it that the most significant and far reaching genetic engineering news comes from the field of genetics in human medicine. Even now, when this technology is still in its infancy, there are success stories being constantly reported. The most progress has been made in the treatment of immune system difficulties caused by genetics, and the number of successfully cured patients has now risen into double figures. There are some people using this treatment who have contracted leukemia as a side effect, but this is likely to be overcome in the future as the technology develops.

GM PLANTS

All forms of genetic modification (GM) take one or more genes from one species and introduce it into the DNA of another in order to create a "transgenic" organism with different characteristics. So, for example, a plant may be made more resistant to disease, drought or

pesticides by introducing a foreign gene from another species into its genome. While many people and organizations still object to such a practice, it is worth remembering that the exchange of genes occurs constantly in the natural world and is the basis of the process of natural selection that keeps us alive.

One of the first GM plants was created at the University of California in 1986. Here, some tobacco plants were transgenically altered with a gene from a firefly to make them bioluminescent. The result was GM tobacco capable of emitting a glow. This very much caught the public imagination, although the intention of the scientists was to allow them to track the successful transfer of genes between species, rather than to harvest glowing plants!

The first commercial GM plant was the Flavr Savr tomato. Created by Calgene, this was licensed for human consumption in 1994. Specifically, Calgene used "gene silencing" technology to shut down the gene that causes tomatoes to rot, so allowing the GM produce to stay firm for longer after harvest. Following the Flavr Savr tomato, a company called Monsanto began to introduce a range of corn and other GM crops. Today, around 90 per cent of the corn, cotton and soybeans grown in the United States are GM. China, Brazil, Argentina, Canada, Paraguay and South Africa also grow large quantities of GM crops. However, despite the improved yields, pesticide resistance and disease resistance than GM offers, across Europe GM crops remain banned.

GM ANIMALS

Transgenic animals have also already been created. Way back in 1986 the first transgenic mice were genetically altered to develop cancer. Since that time the creation of "humanised" transgenic mice and rats for research purposes has also almost become routine, with a company Ozgene having being creating transgenic rodents for over twenty years.

A new breed of "enviropig" has also now been transgenically created by the Guelph Transgenic Pig Research Program to produce a more environmentally-friendly form of manure. Back in 1996, the Roslin Institute in Scotland also successfully managed to clone a sheep called "Dolly"

by transplanting an udder cell nucleus from one sheep into an empty egg cell from another. Since that time the same technique has been used to clone pigs, dogs and horses.

Today, we are on the brink of the approval of the first GM creature to enter the human food chain. Created by a company called Aqua Bounty Technologies, the AquAdvantage is a transgenic salmon that has had ocean pout and chinook salmon genes spliced into its DNA. The result is a fish that grows to full size in 18 rather than 36 months. While the pending approval of the AquAdvantage for human consumption may prove controversial, in the face of future food shortages we may well need a whole host of such rapidly-growing animals in order to fend off mass starvation.

GM MICRO-ORGANISMS

For centuries natural fermentation processes have been used to produce products including cheese, beer and yoghurt. However, since the birth of genetic engineering in the 1970s, genes have also been spliced between micro-organims in order to enable the creation of products using transgenic E.coli bacterium and other micro-organisms. Indeed today, biotechnology is a $200 billion global industry.

Today, transgenic E.coli bacteria are used to produce all manner of things including chymosin (as required in the making of cheese), as well as synthetic insulin, human growth hormones, and first generation bioplastics and biofuels. As detailed on the synthetic biology page, next generation medicines, biofuels and bioplastics are now also on the horizon.

GENETIC TESTING

Ever since the completion of the Human Genome Project, hopes have been high for the application of genetic engineering in healthcare. While progress has been slower than the media anticipated -- and the role of most of the genes in human DNA is far from understood -- already more than 1,000 human genetic tests are available. These enable couples who conceive a child using in vitro fertilization (IVF) to have embryos screened for the genetic mutations that cause cystic fibrosis, sickle cell disease, spinal muscular atrophy, and a range of other conditions. It is

also now possible to obtain a genetic test for many conditions over the Internet, with the process now as straight-forward as point, click and spit.

Major research is also underway into the genetics of cancer. For example the International Cancer Genome Consortium has been set up to generate genetic data on up to fifty of the most common types of cancer. In time, this work should allow doctors to test for and diagnose cancers based on their genetic characteristics. Further into the future, cancer gene therapies may also result.

Since the Human Genome Project, was fully completed in 2003, scientists have learned that the role of individual genes in human DNA is far more complex than first thought. Not least, the "expression" (or level of activation) of a gene has been found to be as least as medically important as gene composition. Significant progress in genetic testing -- let alone genetic treatments -- are therefore likely to require doctors to be able to test patients for far more than mutations in one or a few genes. Fortunately, this is also likely to become possible, and relatively soon.

When the Human Genome Project was fully completed in 2003, the sequencing of an individual human genome took thirteen years and cost three billion dollars. Yet today, a Californian company called Illumina can already sequence an individual human genome in eight days for about $10,000. By the middle of this decade, a company called Pacific Biosciences is already predicting that it will be able to sequence an individual human genome in fifteen minutes for less than $1,000. What this incredible progress will make possible is a whole new approach to medicine called pharmacogenetics.

PHARMACOGENETICS

Pharmacogenetics -- also known as pharmacogenomics -- is the study of how genes influence a person's response to drugs. It has always been obvious that different people respond differently to the same medication. However, it has usually not been known why. The promise of pharmacogenetics is to alter this situation by allowing doctors to select treatments based on the genetic makeup of each individual patient.

Pharmacogenetics will also allow prescriptions to be calculated based on a person's genetics rather than purely their weight and age. Vaccines will also be able to be genetically targeted, with different strains for different patient DNA profiles. In addition, pharmacogenetics will allow medicines that work very well in some people but cause major side effects in others to be safely brought to market as it will be known who will react badly to them and who will not.

Before widespread, individual genome sequencing becomes routine, a critical pharmacogenetic technology is likely to be the gene chip. Gene chips are medical sensors about the size of a matchbox, and feature a tiny "DNA microarray". Every square on this grid contains a particular DNA snippet. When a sample of patient DNA comes into contact with the gene chip this causes some of its squares to illuminate, so revealing the level of activation of particular genes. By examining the gene chip under a microscope a patient's genetic suitability for certain drugs can thereby be assessed. Experimental gene chips are already available from suppliers including Affymetrix.

GENE THERAPY

The ultimate goal of genetic medicine is to cure health complaints at the genetic level. Potentially, several mechanisms exist that could be used to insert additional or replacement genes into a patient's DNA. These include the use of gene transfer agent viruses known as "vectors" to deliver therapeutic genes to target patient cells. Alternatively, therapeutic genes may be coated with artificial liposomes. These fatty substances adhere to the surface of cells and may therefore encourage attached genes to enter into them.

Gene therapy trials have been taking place for over a decade. For example, a baby called Rhys Evans who suffered from an immunodeficiency called X-SCID received a gene therapy treatment way back in 2001. While this was successful, other human trails have resulted in serious side effects -- such as leukemia -- and even some patient deaths. In 2008, a significant success was reported using gene therapy to cure inherited blindness. However, gene therapies for most conditions probably remain many decades away.

For the fact that prospects of genetic engineering is a fact, but on the issue of genetically engineered humans, it’s still stands as potential issue waiting to be actualized and the idea of cloning is still in progress. In our world today this revolves around human beings. Imagine for a

second that in addition to the humans we know, we had another category of 'in-humans' who are just a little different, but that difference is enough for them not to be perceived as humans. And now imagine what happens next. Will they live among us, or will they want to have their separate territories? Will they live peacefully with us, or will there be a struggle? Will they be better than us and take control of us and may be making us a secondary species on this planet? Or will they be inferior to us and enslaved by some of our brethren? This could somehow be linked to fictitious aspect.

7. THE DANGERS OF GENETIC ENGINEERING

For the fact that there are dangers in genetic engineering, it is obvious therefore that such things/genetic engineering is more of facticity/facts than could be thought to be fictitious/fiction. The problem that could be discussed is thus based on the disasters from human genetic experimentation. A few mutations (genetic modifications) may never get noticed immediately, but when combined with further natural mutations, prove extremely deadly. This includes that the prospects are facts.

8. CONCLUSION

Genetic engineering is a complicated process that can be used for many things from modifying organisms such as plants to serve humankind better, to developing helpful pharmaceutical products, and even providing clues to the evolutionary process (Levine). Despite the fact that the genetic manipulation process seems to result in more damage than help, these views are often exaggerated. Although no one can predict the future of any field of human endeavor, genetic engineering appears to be a feasible mechanism through which many problems of modern society can be solved.

BIBLIOGRAPHY

Ekwutosi, Cosmas M.(2008), *Bioethics: history and contemporary Issues*, Anambra: Rex Charles and Patrick Limited,

Steinbrecher, Ricarda. (1998), "What is Genetic Engineering?" July.

Panteleon Iroegbu (2002), Kpim of Ethics; Owerri, Assumpta Press.

Encyclopedia Dworkin, Martin.(1989) "Pfasmid." Lexicon Universal Encyclopedia. New York.

Donnelly, Julie. (2000), "Gene Therapy." April.

Levine, Louis(1989), *Genetic Engineering*, New York: Lexicon Universal Encyclopedia.

Rubenstein, Irwin. (2002), " *Genetic Engineering*, World Book Online Americas Edition. 9.